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(54) **Preserving foodstuffs**

(57) A preserving liquor comprises at least one non-toxic organic acid, e.g. tartaric, citric or lactic acid in a sufficient amount for the liquor to have a pH of 4.1 to 4.5, at least one salt of a non-toxic organic acid, e.g. sodium benzoate or potassium sorbate and at least one preserving agent which is sodium chloride or a saccharide, e.g. saccharose, fructose or glucose. Examples of preserving fruit and spinach in sealed containers are given.

GB 2 061 693 A

SPECIFICATION

A method for preserving perishable organic matter in sealed containers, to a preserving liquor to be used in said method, and to the products obtained by said method

This invention relates to a method for preserving perishable organic matter in sealed containers, to a preserving liquor to be used in said method, and to the products obtained by said method.

The problem of preserving foodstuffs in perfect conditions during comparatively long periods of time, from at least one to several years, is about as old as mankind itself and it still stimulates in all the world researches which are considered of prime importance for humanity.

Thus, in the field of preservation of edible vegetables and fruits, there are three main general methods used at this end, the first one being preservation by means of refrigeration (in general without previous treatment), the second one being preservation in sealed containers (with a previous preserving treatment in general by heat), and the third one being preservation by chemical agents. Each of these general methods have their own characteristic advantages and drawbacks.

Referring firstly to the method of preservation by refrigeration in special refrigerating chambers, it may be considered in general due to its high initial installation cost, its maintenance cost and specially the high amounts of energy required for the permanent operation of the equipment. Considering the last of the above-mentioned factors, it fixes an upper limit on the period of time during which foodstuffs may be preserved, at which the selling price of the product will no longer compensate for the high price of the consumption of energy during the preservation period.

Furthermore there is always the risk of a long interruption in the supply of electric energy, which may be due to a failure in the power generating plant, in the power distribution lines or to operational breakdowns in the refrigerating plant itself. In such a case, large amounts of products can be lost forever, since it will be necessary to consider them unfit for human consumption. The only way of avoiding this possibility is to provide the refrigeration plant with an auxiliary moto generator equipment which automatically starts operating in case of failure in the external power supply. This auxiliary equipment must be capable of supplying comparatively high power; its correspondingly high cost will raise still more the selling price of the preserved products. Another factor is that the temperature in the refrigeration chambers must be strictly controlled within narrow limits. If the products are subjected to an excessively low temperature, the water content of the cells of the organic matter will freeze rupturing the cell walls thus liberating substances which may alter the taste, aroma, texture and visual appearance which are characteristic of fresh vegetables, fruits and the like. If the products are insufficiently refrigerated fermentative and enzymatic processes and the like will start, producing progressive degradation and the final decay of the product subjected to refrigeration. Moreover, a too extended period of time of refrigeration will cause the loss of the organoleptic characteristics of the original product.

Another drawback of the preserving method based on the use of cold is the fact that when the products must be transported from one place to another, the means of conveyance must also be provided with a suitable cold-producing equipment. Such is the case when trucks, railway freight-cars, seacraft, aircrafts and the like are used. All this increases considerably the selling cost of the products.

The second method of preserving perishable organic products consists in preserving them in hermetically sealed containers, both the container and its contents being subjected to particular treatments which in general involve heat.

A widely used method of this type is the method known as "Appert Process". It is used both for preserving fruits in sugar syrup (such as preserved peaches and the like) and for preserving edible vegetables in saline solution (such as green peas and the like).

According to the Appert Process, the product and the container are subjected to a temperature of 115 to 120°C during a period of time of 20 to 25 minutes. The so treated containers and their contents are stored at a temperature of more than 20°C to verify whether in spite of the heat treatment, some fermentation develops in one or more of the containers. Sometimes small amounts of certain additives are added, such as agar-agar, Garugandra amorphoides, gums (such as gum Arabic) or gelatin (which requires rather critical conditions of treatment). In general, the object of adding such additives is to maintain the original taste of the product as much as possible; sometimes there is added sodium benzoate and potassium sorbate to prevent fermentation when the heat treatment takes place at less than 100°C.

Obviously, the high temperature used in the Appert Process inevitably and permanently renders useless the enzymes and vitamins and reduces the proteinaceous values. Decomposition of the organic material contained in products such as fruits and edible vegetables, specially when they are highly perishable, takes place by the action of the enzymes contained in these substances, which tend to hydrolyze celluloses and carbohydrates. The action of the mycotic microorganisms (fungi) produces fermentations and, by the action of certain bacteria, putrefaction finally develops. If conditions are established to prevent fermentation processes and the development of fungi, the action of the enzymes may however produce undesirable changes in the natural organoleptic characteristics of the fresh product.

When products such as fruits and edible vegetables are preserved in sealed containers which are subjected to the Appert Process or the like, or in general to the action of heat, the enzymatic activity is stopped, the properties of vitamins are destroyed, and proteic material tends to be hardened. This har-

dening affects specially the texture of the end product, altering the oranoleptic characteristics and palatability of the original material, thus making it necessary to use a considerable amount of sugar or salt, according to the organic matter which must be preserved. The nourishing value of the end product is highly diminished. The Appert Process moreover requires the production and consumption of considerable amounts of steam when the products are treated in an industrial plant of certain importance. Since the temperature and steam pressure within the containers are high, it is advisable not to use glass or plastic material containers. Thus tin cans are almost always used.

It is known that such tin cans must receive a covering treatment before they can be filled with the desired contents, such covering comprising a special film capable of preventing oxidation and/or attack by the materials which must be preserved in said cans. Even microscopic discontinuities or pinholes in this covering film may expose the metal to attack by chemical agents with the consequent oxidation and corrosion problems which in their turn will damage the contents introduced into the can, by way of different chemical reactions. When the product is salty or contains strong free acids (pH less than about 2) there exists the possibility that the container metal will be attacked even if it has the above-mentioned protecting film covering. Another important drawback of the Appert Process, and other similar processes, is that they require an important amount of workmanship, since a previous conditioning of the containers is necessary, whereafter they must be examined; there is also the risk of explosion of one or more of the containers in a production line during the sterilization process due to the internal pressure of the steam generated within the sealed container and to failures developed in the container during its manufacture.

It is possible to reduce by 15 to 20% the cost of the Appert Process by the use of highly automated equipment, but the equipment itself is very costly.

The third method (preservation by means of chemical agents) may change too much the organoleptic characteristics of the end product, and the most effective agents are generally toxic (at least when used in effective amounts). The chemical agents have also a relatively high cost.

The present invention aims to provide a method for preserving perishable organic matter in sealed containers, which in general avoids the above-mentioned drawbacks.

The method of the present invention does not require the costly refrigerating equipment and high consumption of electrical energy during the entire period of preservation and transportation nor special storage facilities which are necessary in the case of the preserving processes which are based on the use of cold.

The present method provides also a product which maintains the original texture, organoleptic characteristics, colour and the like of the natural product.

Another advantage of the present method is that it can be used with both, tin cans and glass or plastic material containers, without the risk of explosion of the containers, which will not be attacked by the chemical components of the contents and will not require special precautions. Moreover, this method does not require the generation and use of high amounts of steam, or the installation of complicated equipment. It also offers the possibility of using glass containers without any risk of explosion, this type of containers having the advantage of allowing the visual exhibition of the end product in its container.

Thus, one of the objects of this invention is to provide a method for preserving perishable organic matter in sealed containers, a preserving liquor to be used in said method, and the products obtained by said method.

Another object is to provide a method of the kind mentioned which allows preserving the products in sealed containers during a substantially indefinite period of time (up to several years), the product maintaining all its original properties such as texture, organoleptic characteristics, colour and the like.

Another object is to provide a method of the kind mentioned which is economical to put into practice since it involves a moderate initial and maintenance investment and it does not require high amounts of electric power or steam.

Another object is to provide a method of the kind mentioned which is safe to handle since none of the additives used is toxic or dangerous in any other way, no high temperatures are used which could produce burns to the workmen handling the equipment and the containers, and which does not require special facilities of the storage of the final product. Neither is there the risk of spoiling great quantities of stored products due to failure of equipment, or to the lack of electric power, as may be the case when preserving products by refrigeration.

Another object is to provide a method of the kind mentioned which does not destroy the enzymes, but only inhibits transitorily their activity which will start again when the container is opened and the contents are separated from the preserving liquor.

Another object is to provide a method of the kind mentioned which preserves enterily the vitaminic values of the original products.

Another object is to provide a method of the kind mentioned which does not produce coagulation of the products, since it does not require the use of temperatures higher than 70°C.

Another object is to provide a method of the kind mentioned in which a preserving liquor is used which has nourishing values by itself and may be used as a syrup when preparing other foodstuffs, such as desserts, independently from the solid organic matter, which has been preserved in the container.

Another object is to provide a method of the kind mentioned which fully maintains the natural texture of the original material, according to the kind of material which is preserved (in the case of fruits, the texture will be more fibrous when the fruit is still green).

Another object is to provide a method of the kind mentioned which fully maintains the natural taste and flavour of the original material; the organic compounds and essential oils and other volatile

substances, which are responsible for the taste and flavour of the organic matter, are not affected by this method, since no temperatures are used which may produce an alteration of said organic compounds, essential oils and other volatile substances, and of the proteins. Thus not only the original taste and flavour will be preserved, but also the original colour and the natural visual appearance. Thus there is no need to add colouring agents to correct a loss of natural colour due to treatment.

These and other objects and advantages of the present invention are attained by providing a method for preserving perishable organic matter, such as foodstuffs, in sealed containers, comprising the steps of: (A) conditioning the organic matter, which must be preserved, stripping it from its components not desired in the final product; (B) introducing the organic matter, obtained according to (A), into suitable, previously conditioned open containers; (C) introducing said containers, still in their open condition, into a substantially hermetic zone which is connected to vacuum producing means; (D) subjecting said organic matter in said zone to a gradually decreasing pressure until a final pressure of not more than about 90 mm of Hg is attained; (E) maintaining this final reduced pressure during enough time, according to the nature of said organic matter, to remove substantially all of the oxygen and carbon dioxide contained in said organic matter; (F) preparing a stabilizing and preserving liquor comprising (1) at least one non-toxic organic acid in the necessary and sufficient amount to obtain in the liquor a pH of about 4.1 to 4.5; (2) at least one salt of a non-toxic organic acid in the necessary and sufficient amount to transitorily stop substantially all metabolic processes normally taking place in said organic matter; (3) at least one agent, selected from the group comprising sodium chloride, and a saccharide, in the necessary and sufficient amount to be capable of preserving the texture and taste of the fresh original organic matter, and (4) water as the solvent for the components (1), (2) and (3); (G) filling the containers, while they are still subjected to said reduced pressure, with said stabilizing and preserving liquor in the amount necessary to cover at least with a slight excess, the upper level of said organic matter in the containers; and (H) sealing said containers.

The invention will be better understood through the following description and examples.

So as to allow a better interpretation, by those skilled in the art, of the principles on which this invention is based, it is considered convenient to begin with a discussion of the biological and chemical characteristics and properties of the different kinds of organic matter which it may be desired to preserve.

From what has been said at the beginning of the specification, it is obvious that in the art of preserving perishable organic matter such as foodstuffs, three main methods are known: (1) preservation by low temperatures (cold); (2) preservation by initial heat treatment (the Appert Process being the best known); and (3) preservation by chemical additives.

The present invention pertains to the third group mentioned above. However, it has none of the drawbacks of such presently known methods.

This invention is the result of a careful analysis and study of the nature of the biological constitution of organic matter and the vital processes which take place in living matter. While this invention is applicable to organic matter of vegetable or animal origin, the following description will be given relating only to matter of vegetable origin. However, those skilled in this art will easily understand that in general the same considerations will be also applicable to the case of matter of animal origin (such as meat, seafood and the like, with some obvious differences.

Thus considering the case of matter of vegetable origin, the complete structure of a plant, comprising roots, stems, branches, leaves, flowers, fruits and seeds, are composed of the following elements and chemical compounds in the following percentages:

Elements and Compounds	Minimum and Maximum in Raw Material (%)
N	0,5 to 1,2
P_2O_5	0,4 to 0,6
K_2O	1,2 to 3,0
CaO	0,03 to 0,05
Fe_2O_3	0,05 to 0,07
SO_3	0,005 to 0,07
Cl	0,2 to 0,3
Na_2O	0,2 to 0,9
SiO_2	0,03 to 0,1
O_2 and CO_2 (gases)	variable

Matter of vegetable origin contains also other trace elements such as Cu, Mn, and the like, according to the composition of the soil on which the plant grows and feeds, and which take part in the vital processes, but not in a quantity sufficient to affect the natural preservation of the different parts of the plant.

The water and the minerals which are necessary for the growth of the plant are extracted from the soil by the root, rising the capillary action (ascending sap) to the upper parts of the plant where the respiratory action and photochemical action of sunlight produce a series of chemical reactions ending in the formation of different more or less complex chemical compounds and these, by way of the descending sap, are distributed to all parts of the plant originating the following compounds:

1) Water
2) Starch
3) Celluloses and hemicelluloses
4) Pectines
5) Proteins
6) Sugars
7) Enzymes
8) Vitamins
9) Tannins
10) Fats
11) Essential oils
12) Mineral complexes
13) Pigments

Of course, plants contain other components besides those mentioned above, according to the species; however, they are the basic components which may affect the preservation of the main characteristics of the preserved final product, such as taste, flavour, texture and organoleptic characteristics, and which must thus be taken into account when considering the feasibility of any preservation process for perishable organic matter, such as foodstuffs.

All of them have a common origin and are generated by photosynthesis processes, taking CO_2 from the air in the presence of a solution or suspension in water of the components extracted from the soil (ascending sap) and thereafter are distributed through the entire plant (descending sap) producing the development of the several parts thereof by way of chemical phenomena, physico-chemical phenomena (hydrolysis, reductions, polymerizations and the like) and through biological processes in the presence of catalysts, such as enzymes, fungi, ferments and bacteria. Each of the above-mentioned main components of vegetal tissues will now be considered.

1) *Water.* – This is the essential component of all living tissues, since all the above-mentioned phenomena develop in liquid media and the inorganic products taken by the plant from the soil from colloids and solutions, and the very existence of each cell requires the presence of a certain percentage of water which is taken from the soil since the appearance of the first trace of root. This vital process is produced by the descending and ascending saps. Water is not only essential for the life of the plant, but is also very important during processes of preserving perishable organic matter in a truly natural condition. By excessive cooling, the water contained in each cell may form ice which ruptures the cell walls totally altering the natural taste and flavour of the preserved product. By excessive heating, water changes into steam, with the same end result of rupturing the cell walls and with the possible added effect of undesired chemical reactions.

2) *Starch.* – From a purely chemical point of view, starch could be included under the general designation of carbohydrates together with cellulose, hemicellulose, sugars and other chemical compounds existing in plants. However, in order to better interpret the processes which take place in the plant and to explain the methods used for arresting the vital process at the stage of development of the plant at which its organoleptic characteristics satisfy human taste and maintaining at the highest possible degree its nourishing values, capability of assimilation by the digestive tract, its vitaminic content and the like, it has been considered preferable to discuss starch separately, both from the viewpoint of its chemical constitution and of the processes of formation and decomposition (degradation) of vegetal matter. It may be safely assumed that starch is the basic food component around which develop the biological processes leading towards the start, development, ripening and decay of vegetable matter. Its basic chemical composition is as follows:

$$(C_6H_{10}O_5)$$

or, in general terms: $(C_x(H_2O)_y)_n$

though these empirical formulae do not give any explanation of their structural constitution. Starch is a polysaccharide of high molecular weight which, through the action of enzymes, ferments bacteria or dilute organic acids, causes hydrolyzation or polimerization phenomena. A typical case is the production of glucose ($C_6H_{12}O_6$) which occurs both in nature and in the laboratory or during industrial manufacture. By way of other reactions of the most different characteristics and under the most different conditions, starch also produces other sugars or other organic compounds which may contain mineral elements which confer upon them definite characteristics. Thus, by way of a dehydration reaction, compounds are obtained which have a similar structure but a very high molecular weight, such as cellulose where *n* has a value from 50 to 3,000, hemicelluloses (pentosanes) and lignin. The latter may be considered as the end product of the transformation or degradation of starch in function of time. Cellulose represents the resistent structure of the plant cells.

Through the action of enzymes, the presence of inorganic elements and photo-chemical action (photosynthesis), other compounds are formed starting from starch; those other compounds characterize the organoleptic values. The following may be mentioned: glucose, sugar, pectins, proteins, tannins, fats, essential oils, pigments, and the like. The nearer the ripening stage is, that is to say, the stage of maximum development, the less the starch content will be. An example is the banana, in which the starch content is reduced from about 7% to only about 1%, finally disappearing when the ripening process has been completed and the organic material begins to decay. Eventually, when final dehydration conditions prevail, starch may be finally converted solely into cellulose and lignin.

With regard to the problem of preserving organic matter of vegetable origin, starch does not present serious difficulties, since its content in the organic matter is rather low and it is easy to arrest the activity of the enzymes which are responsible for its transformation. An exception is the case of tubers such as potatoes, manioc and the like, the preservation of which is possible to achieve only by the action of temperature and dehydration.

3) *Cellulose and Hemicellulose.*— Hydrolytic and photochemical action bring about the formation of high molecular weight polymirezed compounds, cellobiose ($C_{12}H_{22}O_{11}$) being the compound initially produced. The cellulose molecule is integrated by way of a polymerization reaction forming a long chain of cellobiose molecules. Cellulose is a compound representing the main structural material of vegetable tissues. It is insoluble and is thus highly stable. During the storage of perishable organic matter, such as products of vegetable origin, it is necessary to maintain the material in a condition that is as near as possible or equal to the original condition of the fresh material in order to be able to obtain an end product having substantially the same original texture. The photochemical and enzymatic reactions acting on starch produce not only hexoses, which are the basic con-

stituents of cellulose, but also pentoses which, by way of successive hydrolytic reactions, are converted to aldopentoses which finally polymerize to hemicellulose, this latter complementing cellulose to form the plant tissues. The chemical composition of hemicellulose may be expressed by the same general empirical formula $(C_x(H_2O)_y)_n$, but comprising an L-arabinose chain. The preservation of cellulose and hemicellulose requires preventing the possibility of oxidation, and thus the activity of cellulose and hemicellulose must be inhibited.

4) *Pectins.* — Pectins are indirectly produced when starch is converted to an hexose (d-galactose) and by oxidation of the latter forms a long chain of galacturonic acid units which are responsible for the gel formation characteristics. Thus, its general empirical formula is the classic one $(C_x(H_2O)_y)_nO$ wherein *n* has a value which is always less than the value of *n* in the case of cellulose and hemicellulose. It may be said that they are derived from hemicellulose considering the similarity of many of their chemical characteristics. Pectins have a very similar function, forming a viscose between adjacent cells (lamella intermedia). Pectins are more commonly found in plants and young fruits, specially in the layers near the external membranes (stems and fruits). They have high inhibitory capacity and a very important function in fruits. The pectic substance of the *lamella intermedia* of cells and intercellular channels absorb water from the outside and from the cellular fluids, passing more rapidly than if it were transferred from cell to cell by osmotic pressure. This is the reason why fruits become juicier as the ripening process advances, during which the pectin content decreases progressively. Pectins are chemically sensitive to temperature, since heat coagulates them and renders them insoluble. They are also sensitive to the action of enzymes (pectinase) which converts them again to sugar, glucose and fructose, and to the oxidant action of oxygen which produces a degradation commonly known as "carbonization" due to the dark brown colour which the plant acquires. However, they may be preserved if a suitable pH is maintained, which also allows a better assimilation by the human body. Pectins behave according to their molecular weight; the higher this is, the greater is their viscosity; thus they soften the taste of vegetables, preserving their flavour (specially in the case of sweet fruits) and fixing their aroma by avoiding the resinification of essential oils due to oxidation. Thus, it will be obvious that maintaining pectins in their natural condition is an essential requirement for preserving the original texture and taste of the original material in the end product.

5) *Proteins.* — Proteins are the main nitrogenous components of plant tissues. Their importance derives not only from the fact that they are necessary for assimilation by human beings, producing compounds which are essential to muscular development, but also because they have high energetic value. In seeds they represent the base for the germinative process and later on they take part in the formation of aromatic compounds and flavouring agents. They also take part in the formation of viscous compounds which act together with pectins. Proteins contain about 50% of carbon, 25% of oxygen, 15% of nitrogen and 7% of hydrogen. Phosphorus and sulphur may also be found in some proteins. In general, they are soluble in water producing colloidal solutions. However, they may also form acid or basic solutions, and by hydrolysis they may form a mixture of amino acids. The protein content of vegetable matter is in general low, with the exception of the seeds of certain types of seaweeds, and each species of plant has its own characteristic proteins. About 60% of them are constituted by amino acids. Proteins may be classified into two types: (1) insoluble or fibrous animal proteins which constitute the main part of hair, wool and conjunctive tissues; and (2) vegetable and animal proteins which are soluble in water, water-alcohol mixtures, alkaline solutions, and diluted acids or alkalis.

Soluble Proteins may be classified as follows:

i) *Albumins.* — Proteins of animal origin which are soluble in water.

ii) *Globulins.* — Insoluble in water but soluble in diluted solutions of neutral salts; found in animal and vegetable tissues. Under special conditions they are amphoteric and take part in metabolic processes, and are coagulated by heat. While their importance in a food preserving process is rather relative, it is more convenient to maintain them stabilized by not heating them to more than 65°C.

iii) *Glutelins.* They are insoluble in water or in diluted solutions of neutral salts, but soluble in acid or basic diluted solutions, specially in acid diluted solutions having a pH of not more than 4.5. They are found in seeds (where they act in the germinative process), in seaweeds and in certain fruits. In fruits and flowers they stabilize the essential oils which give the flavour and the volatile substances which give the aroma. They are stable at a pH of not more than 4,5.

iv) *Prolamins.* Insoluble in water or in diluted saline solutions, but soluble in up to 80% alcohol solutions. Found in seeds and in the flesh of fruits. Their main specific function is to act in the formation and germination of seeds. All prolamins are vegetable proteins and, as in the case of glutelins, it is necessary to prevent that heat or decomposition processes may affect them. They must not be heated at more than 65°C during more than 25 minutes. Sugars are useful in stabilizing them.

v) *Histones and Protamins.* — Basic proteins soluble in water and thus also in acids. Specifically they are animal proteins; however it has been mentioned that they have been found in vegetables whose habitat is water, such as seaweeds.

However, soluble proteins are less soluble near their iso-electric point. Thus, it is important to establish the composition of the solutions in which they must be stabilized, so as not to change the texture, taste and/or aroma. Since they become insoluble in the presence of mineral acids, it is necessary to use organic acids to maintain suitable conditions of acidity or pH. In this manner, it will be possible to maintain them within the cellular structure. One of the characteristics of proteins is their ability to undergo structural and physical changes known as

"denaturalization" which depend on temperature. This is why they lose or reduce their solubility in proportion to their heating and are no longer crystallizable. The upper limit of 65°C during 25 minutes has been already mentioned above as the maximum permissible while maintaining them in their natural condition, this being the reason why protein solutions may be maintained during long periods of time at 0°C, but are denaturalized when heated above the mentioned limit, thus becoming difficult to handle; however they may be recuperated if a suitable pH is maintained. Animals can not synthesize proteins and thus must receive them by way of their food. Human beings have stricter requirements and demand that their food have a pleasant taste and texture and that it have characteristics which in general are as near as possible to those of the natural product. When devising a food preserving method it is necessary to bear in mind all these factors.

6) *Sugars.* While it would have been possible to include sugars when discussing starch (considering sugars as carbohydrates) it has been considered preferable to discuss them separately. It has already been mentioned above that, by way of enzymatic processes and mainly due to the action of amylase, disaccharides such as sucrose ($C_{12}H_{22}O_{11}$) and monosaccharides such as glucose ($C_6H_{12}O_6$) are produced. It is believed that in vegetables, disaccharides are first produced until all or near all the starch originally present has disappeared. Through the action of another enzyme, diastase (and also dilute acids), hydrolysis takes place splitting sucrose in two monosaccharides; glucose (or dextrose) which is dextrorotatory and fructose which is levorotatory, both having the same empirical formula $C_6H_{12}O_6$. Their different optical characteristics derive from the fact that while the empirical formulae of both monosaccharides are the same, their structural formulae are different. Glucose has a hexagonal ring with six carbon atoms while fructose has a pentagonal ring, with a carbon appearing as an aldehyde radical; thus fructose has a very sweet taste, as opposed to glucose which has a relatively low sweetening power. The molecular structure of fructose corresponds to that of furans and thus is more stable. This process always takes place in the plant and, at large, sucrose splits totally into monosaccharides, when the stage of ripening has been completed; monosaccharides are then attacked by ferments and bacteria, producing different types of fermentation. All these phenomena bring about changes of taste, texture, aroma and sweetness (particularly in the case of fruits). Also the effect of heat produces values which are different from those of the natural product. This embraces what is known under the expression "degradation of fruits". In the first case, bitter or acid tastes are developed; in the second case, that is to say when using heat, decomposition, with its unpleasant sequels, is obviated, but at the same time changes of texture and natural taste and flavor will develop. A typical case are the so called "preserved peaches". In this latter case, a pleasant taste and flavour are obtained by the addition of high quantities of sugar and/or vegetable gums, but it is never the truly natural taste and flavour of fresh and ripened fruits directly obtained from the peach tree.

One way of stopping the action of enzymes, ferments and bacteria consist in maintaining the pH at suitable values, in which case the aerobic activity of some ferments and bacteria and enzymatic activity are stopped.

7) *Enzymes.* Chemical reactions taking place in living cells represent the "metabolism" or metabolic changes and may be divided into "anabolic changes" when they contribute to the development of the plant, and "catabolic changes" when they contribute to the degradation or decay of the cells. When it comes to the preserving of vegetables for human consumption, it is obvious that in general vegetables will be used which have reached the ripe stage or are very near to it. Thus the present invention aims to stop the "catabolic changes", since "anabolic changes" are very limited or entirely absent at this stage of development of vegetable matter. Said chemical reactions may be of the "photosynthesis" or of the "chemical synthesis" type. They are reactions which develop rather slowly, requiring the action of activating and orienting agents. The activating action is characteristic of the enzymes which act as catalysts, while the orienting action is an exclusively genetic function. Enzymes are present in all living organic matter, both of animal and vegetal origin, this action being highly specific and producing always a decrease of the pH, which in green plants and fruits is normally 6 or more, but which decreases during the ripening stage reaching a minimum value of 4.69. If the pH is decreased until a value of 4.1 to 4.5 is reached, the enzymatic activity and thus the anabolic function are stopped; the vegetable matter is thus stabilized in its present state and the enzymatic activity is transitorily stopped; but it will be resumed if the conditions inhibiting enzymatic activity are removed. This inhibition of enzymatic activity may be verified by the change of the pH in the root of a plant, such as in carrots; in the stem of a plant, such as in sugar cane; and in the fruits of a plant, such as bananas, peaches, oranges, avocados, prunes and the like. Once the corresponding portion of the plant has completed its ripening stage, the enzymatic action stabilizes the pH; but at the same time it allows the fungi, ferments and bacteria to start their action and thus the decay or degradation of the plant begins. This decomposition will take place when the water content of the organic matter is enough to allow this process. Enzymes, each having a specific function, may be classed according to the kind of chemical transformation they produce and also according to the way in which the transformation takes place, such as by hydrolysis, oxidation or reduction. In the preservation of vegetable matter, it is of interest mainly to stop the activity of the enzymes which produce hydrolysis and of the enzymes producing oxidation. However, it must be understood that these are consecutive functions; thus if the first is stopped, the activity of oxidases and the consequent activity of reductases will also be stopped, the latter acting in the development of aromas and flavours. Together with the enzymes, co-enzymes (also called co-ferments) will develop. They are thermostable products, being essential for

the development of enzymatic processes, as are also calcium, iron and the like, allowing the development of flavours, pigments, aromas, and the like, which are collateral products responsible for many of the characteristics of vegetable matter. In spite of the fact that they are thermostable, they develop together with the enzymes and their activity stops at the same time as that of the enzymes. In the case of enzymes, temperature speeds up the reaction but it also speeds up their denaturalization. Basically, according to what has been said above, enzymes may be classed into hydrolytic enzymes, oxidant enzymes and reducing enzymes. Between the hydrolysing enzymes which are important to the development of the plant, estearases may be mentioned; they hydrolyze esters and mainly lipase which hydrolyzes fats; proteases which hydrolyze proteins; peptidases which hydrolyze peptides; and carbohydrases which hydrolyze carbohydrates; and specially amylase which hydrolyzes starch, and glucosidase which hydrolyzes carbohydrates. According to what has been said above, it may be seen that stabilizing the enzymes is essential in preserving organic matter. However, the fact that they are labile to the action of heat at more than 65°C must also be taken into account.

8) *Vitamins.* Vegetables and also animals require intermediate products acting as pseudo-catalysts in assimilation processes. Between vegetables and animals the difference is that vegetables are able to synthesize them, while animals must obtain them already synthesized, through their food, whether this be of vegetable or animal origin, with the exception of a few of them which are produced by their own organism. They are organic compounds, usually thermosensitive. They pertain to more than one class of chemical compounds. The absence of vitamins brings about certain diseases in animals, which must obtain them from vegetables or from other animals and thus compensate for its own inability to produce them totally or partially. The main vitaminic compounds are the following.

i) *Vitamin A (carotene).* It is one of the main colouring materials of green leaves and it is found in all plants. It is the main yellow pigment of carrots, of butter and of egg yolk. It is soluble in water, but very scarcely in alcohol or in products having an alcoholic function. Carotene is not by itself exactly Vitamin A, being only the pro-vitamin A which is converted into the true Vitamin A by the liver. It is very sensitive to the action of oxygen and also to a certain degree, to that of carbon dioxide. It is highly thermosensitive, like most other vitamins. While its action in the animal body is well known, it is accepted that in vegetables it has an activity similar to that of chlorophyll xanthophyll and β-carotene in the formation of pigments. The absence or the presence of an insufficient amount of Vitamin A in the food of an animal produces a decrease of weight and of growth in young animals, and also certain ocular troubles, but the main effect of lack of Vitamin A is keratinization of the epithelial tissues. It is unstable, as it tends to oxidize specially when it is heated in the presence of air or liquids containing oxygen in solution.

ii) *Vitamin B.* Also called P.P. factor (pellagra preventive factor or anti-pellagra vitamin). It is the nicotinic acid having the empirical formula $C_6H_5NO_2$. In aqueous solution it is resistent to temperatures not higher than 80°C. It is an antipellagra factor also known as niacin. It is found, in variable amounts, in all fruits. Once the fruits have ripened, it is easily decomposed by the action of oxidases, bacteria and directly by oxygen in the air.

iii) *Vitamin B_1.* Also known as thiamine. It has the empirical formula $C_{12}H_{18}N_4OS\,Cl_2$. It is pharmacollogically used as the chloride hydrochloride. Better defined, it is a quaternary ammonium salt of a substituted thiazole. It is destroyed by the action of heat at 100°C. It is considered as an antineuritic and antiberiberi agent. It is found in variable amounts in all fruits and specially in citric fruits.

iv) *Vitamin B_2.* Technically it is known as riboflavin and it has the empirical formula $C_{17}H_{20}N_4O_6$. Its importance in the growth of vegetables, and specially of animals, has been recognized. It is soluble in water and sensible to the action of oxidant agents.

v) *Vitamin B_6.* Its technical name is pyridoxine or adermine. It has the empirical formula $C_8H_{11}NO_3$. Its absence in the organism gives rise to dermal conditions. It has also effect in the germination of seeds. It is slightly soluble in water, being thermosensitive and also sensible to a high pH.

vi) *Vitamin B_c.* Also known as Vitamin M. Its technical name is folic acid and it has the empirical formula $C_{19}H_{19}N_7O_6$. In aqueous solution it is very resistant to heat, but in the presence of air it is oxidized rather easily by the action of enzymes or by direct oxidation.

vii) *Vitamin C.* Also called antiscorbutic vitamin. Technically it is known as ascorbic acid, having the empirical formula $C_6H_8O_6$. The natural substance which is present in plants is the L-ascorbic acid derived from L-glucose ($C_6H_{12}O_5$). It is easily oxidized when in solution, being a powerful reducing agent. To preserve it, temperatures below 60 to 65°C must be used, avoiding at the same time the presence of oxygen or air.

viii) *Vitamin D_2.* Also known as calciferol. Technically it is activated or irradiated ergosterol, having the empirical formula $C_{28}H_{44}O$. It has an important function in the calcification of bones; however the highest activity is obtained with the natural Vitamin D. It is mainly found in vegetables having a high content of fats and oils.

ix) *Vitamin E.* Also known as α-tocoferol and anti-sterility vitamin. It has the empirical formula $C_{29}H_{50}O_2$. It is soluble in fatty acids and thermostable, but it is easily oxidized in the presence of oxygen or air by the action of oxidases. It is found in a few plants, being present in important amounts in apples, pears and quinces. It is easy to preserve if air is absent in the medium which contains it.

x) *Vitamin K_1.* Also known as antihemorrhagic vitamin. It has the empirical formula $C_{31}H_{46}O_2$. It is found in various green vegetables, is soluble in water and in fatty bodies, thermosensitive, and is oxidable directly by air or by the action of oxidases.

9) *Tannins.* They are complex components, not yet chemically well defined. In general they are believed to be formed by the union of glucose and

digalloyl. They are slightly acid and are responsible for the astringent taste of vegetables, specially green fruits. When the fruits reach their ripe state there often remains only 20% of those originally present. The tannin content in the rind is thrice that of the pulp, stems and roots. They are partially responsible for the color of some vegetables, but under certain conditions of ripening and when the tissues have a high water content, they may oxidize slowly (apples, pears, pineapples, bananas and the like). They are thermally stable but have the property of coagulating proteins when in solution and above 55°C.

10) *Fats.* Descending sap, by enzymatic action, hydrolyzes organic acids and forms esters therefrom, to so produce the fatty matter of vegetables. They represent an important part of the oleaginous vegetables. They are oxidable, producing the special taste called rancidity. In most fruits, the fat content is low, being higher in the seeds. They do not offer difficulties in the preservation of fruits.

11) *Essential Oils and Aromas.* Most often they are organic acid esters, which in the case of aromas have a relatively low molecular weight and high surface tension. Flavours may be produced also by acid esters, or organic acids of medium molecular weight. They are stable at a pH of 4,7 or less, but they are easily oxidized. The banana is a typical example of the first case, while pepper is an example of the second. High vacuum applied during comparatively long periods of time may be useful to remove them, but they are perfectly preserved in aqueous media.

12. *Mineral complexes.* Phosphorus, sulphur, iron and other elements form complexes, as nitrogen does. They are stable to the action of heat and they may act in the fermentation and putrefaction processes, accelerating them, specially in the presence of oxygen and air. In a liquid medium this problem disappears, except when some fermentation process takes place.

13) *Pigments.* The basic pigments of fruits are due to the content of chlorophyll, carotene and xanthophyll and, during the ripening stage, to some tannins. They are sensitive to oxidation and are destroyed during the degradation process. In certain cases they undergo transformation by the action of heat and they may be affected by ultraviolet or infrared radiation. When preserved peaches are treated by the Appert Process, they acquire a characteristic color, which is different from the natural color of the ripened fruit.

14) *Special Aromas.* They are due to the presence of organic acid esters, such as butyl acetate in the case of bananas, which may be extracted by heat or by high vacuum, unless they are contained in the fruit pulp. They are recoverable by dissolution in water.

General Considerations. According to the analysis made above of the different components of vegetables, it will be obvious to those skilled in the art, that it is necessary to avoid the development of oxidation phenomena, enzymatic actions and degradation or fermentation processes if it is desired to arrive at a successful method of preserving perishable organic matter. At the present time, processes are used which are based on the utilization of cold, sterilization, dehydration or chemical preserving additives. Preserving processes by the use of cold have very strict limitations and shortcomings, not only in terms of time, but also due to the total stoppage of the vital processes. It has been demonstrated that vegetables continue breathing even at temperatures below 0°C. The preserving temperatures may be between 0,5 y 10°C. The effect of humidity at such temperatures is very marked and may cause degradation in the case of bananas, apples, pineapples, pears, peaches and the like, since cold does not maintain the equilibrium of the vegetable vital processes. Freezing even by the most modern methods, changes the consistence, structure and texture of the tissues. It must be noted that very few vegetables can resist temperatures below 0°C. Such low temperatures produce the freezing of water which, when crystallizing, increases its volume and ruptures the cell walls. During thawing they lose very easily their fluids. As has been said above, freezing is always expensive due to the cost of equipment and of the energy required to maintain the cold. The risks inherent to this method must also be taken into consideration.

The treatment by heat at temperatures above 100 to 105°C stops all vital processes of vegetable matter and also the action of enzymes; bacteria, fungi and ferments are destroyed and the vegetable matter loses most of its highly important factors and nourishing values; its texture, taste, aroma and flavor are changed also, since their originating factors are labile to heat. This latter characteristic is of uppermost importance, since methods such as the Appert Process and other similar methods provide an effective preserving action only when temperatures above 105 to 110°C are used.

Another possibility is preserving organic matter by adding chemical products which act as preserving or sterilizing agents. A typical case is salting with sodium chloride, the addition of preserving agents such as sulphur dioxide or sodium benzoate or other chemical products; preservation may also be achieved by means of the use of alcoholic media, or by acid produced by lactic fermentations or the like. The methods of this kind are not used for preserving fresh organic matter, but for special preserves such as pickles, sauerkraut and the like.

Neither dehydration nor drying allows preserving in its totality the natural characteristics of vegetables. If most of the water is removed, the conditions of the matter constituting the vegetable tissues will be changed. Even if dehydration is carried on in a very short time, substantial changes will take place and most of the proteins will not recover their original characteristics. A good example are broad leaf vegetables such as lettuce, salt-wort, spinach and the like and also alfalfa, which by oxidation of chlorophyll even lose at least part of their colour. Dessication to the state of dried prunes, figs, peaches and the like, shows clear effects of the oxidation or inversion processes of sugars, pectins, proteins, pigments etc.

Thus, from what has been said above, it will be obvious that the preserving method of this invention, to be able to attain the objects stated at the beginning of the specification must include:

a) Stopping the vital processes by removing gases, oxygen and carbon dioxide;

b) Stopping the enzymatic processes by regulating the pH between 4.1 and 4.5 (although under certain conditions it may be brought to lower limits), thus stopping the activity of enzymes and metabolism;

c) Stabilizing the proteinaceous material and the pectins without causing an irreversible coagulation (vitrification) by the action of the tannin contained in the plant and which by the action of the sorbate forms combinations which at the same time contribute to the formation of complexes which partially prevent coagulation, the product thus maintaining its natural conditions, keeping its taste and aroma, and stopping the hydrolysis of the polysaccharides;

d) Sealing the pores of the tissues by increasing the viscosity of proteins and pectins;

e) Regulating the pH between 4.1 and 4.5 by the addition of one or more organic acids which stop the action of enzymes, fungi and ferments, and eliminating aerobic or anaerobic bacteria; tartaric, citric, lactic and butyric acid and the like may be used to this end and

f) Stabilizing aromas and vegetable oils by the addition of a saccharide such as saccharose and producing, by a solution of the latter, a protecting medium capable of preventing the introduction of gases.

It will be obvious that the first step of the present method must be of course the conditioning of the organic matter which it is desired to preserve. The conditioning operations are not different from what is common in any process of this kind. They may include the previous washing of the raw material, bleaching, peeling, depriving the vegetables of their pits (as in the case of many kinds of fruits), and the like. Washing may be desirable in most cases, although it is not essential for the present method. It may be done with an aqueous solution of no more than 1% active chlorine, and, thereafter rinsing with fresh water. Bleaching may be achieved by immersion in boiling water during a short period of time. Peeling may be done, if no bleaching is used, by means of steam jets or by immersion in boiling water, with the optional addition of 1.5% caustic soda, during 2 to 10 seconds. This manner of peeling is used when thin skin vegetables must be conditioned, such as potatoes, peaches, carrots, tomatoes and the like. After immersion in boiling water they are subjected to thin but strong water jets which loosen the skin and carry it away. In the case of other vegetables it may be necessary to use manual or mechanical peeling (as with oranges, lemons and other citrus and pineapples). After they have been so conditioned, the vegetables may be subjected to the other steps characterizing the present method.

The method of this invention thus comprises the following sequence of steps:

A) Conditioning the organic matter which must be preserved, according to what has been explained above, depending on the kind of vegetable which must be treated; some vegetables may be cut into pieces of suitable size, while others may be preserved in their whole condition;

B) Introducing the organic matter, obtained according to (A), into suitable open containers previously conditioned (washed, sterilized, dried and the like);

C) Introducing said containers, still in their open condition, into a substantially hermetic zone connected to vacuum producing means; This zone may be a closed chamber in which the containers and their contents are treated in bath fashion or it may be a zone through which a conveyor runs, carrying on it the containers, entering into the zone and leaving it, respectively, through inlet and outlet gates capable of maintaining the vacuum within the treatment zone and so allowing to treat the containers in a continuous operation;

D) Subjecting said organic matter in said zone to a gradually decreasing pressure until a final absolute pressure of not more than about 90 mm of Hg is attained, and preferably of 25 mm of Hg or less;

E) Maintaining this final reduced pressure during enough time, according to the nature of said organic matter, to remove substantially all of the oxygen and carbon dioxide contained in said organic matter; in general, the time during which the treatment under said final reduced pressure must be maintained will be from 10 to 25 minutes; in the case of a continuous process, in which the containers are carried through the zone by a conveyor, the speed of the latter and the length of the zone must be correlated so as to allow the proper dwelling time of the containers in said zone, this time being adjustable, within certain limits, by adjusting the speed of the conveyor;

F) Preparing a stabilizing and preserving liquor comprising (1) at least one non-toxic organic acid in the necessary and sufficient amount to obtain in the liquor a pH of about 4.1 to 4.5; (2) the salt of a non-toxic organic acid in the necessary and sufficient amount to transitorily stop substantially all metabolic processes normally taking place in said organic matter; (3) an agent selected from the group comprising sodium chloride and a saccharide in the necessary and sufficient amount to be capable of preserving the texture and the taste of the fresh original organic matter, and (4) water as the solvent for the components (1), (2) and (3); the solvent (4) must be of drinkable quality, but need not to be bacteriologically pure, since the chemical ingredients added prevent the presence of bacteria; some examples of non-toxic acids (1), which may be used in this method to adjust the pH of the liquor, are tartaric acid and citric acid and, for certain kinds of products, lactic acid may also be used; the upper limit for these acids is about 3.5% although it may be advisable to fix a less high upper limit for certain kinds of products which must be preserved, the lower limit being about 0.2% although it may be advisable to fix a higher limit in the case of certain products; obviously a mixture of acids may be used, in a total amount comprised within the limits stated above; an example of a salt of a non-toxic organic acid (2) which may be used is potassium sorbate, its function being to stop the metabolic processes which normally take place in the organic matter which must be preserved, such as the development of fungal microorganisms, bacteria and fermentative

processes, also stabilizing proteins and pectins; the amount which may be used is comprised between the upper and lower limits of 0,1 and 0,35 ‰ by weight of the liquor, it being obviously possible to use a mixture of two or more of these salts in a total amount comprised within the limits stated above; examples of agents (3) are sodium chloride and various saccharides; sodium chloride, besides its preserving effect, acts also as a softening agent, being used mainly in preserving certain vegetables such as green peas, spinach and the like, in an amount not higher than about 2% according to the texture which it is desired to obtain in the end product; examples of the saccharide (3) are saccharose, glucose, fructose and the like, which are of natural origin, while synthetic sweetening agents like saccharine may also be used under the provision that they must not be sensitive to the action of the acids used for the components (1) and (2); the type and the amount of the agent or agents (3) will be selected according to the taste and texture desired for the end product, the upper and lower limits for the saccharide being comprised between about 3 and 25%, respectively.

G) Filling the containers, together with their content of organic matter which it is desired to preserve, while they still are subjected to said reduced pressure, with said stabilizing and preserving liquor in the amount necessary to cover, with at least a slight excess, the upper level of said organic matter in the containers; while the still open containers are maintained in said substantially hermetic zone connected to vacuum producing means, they are filled with the liquor prepared according to (F) until the upper level of the liquor at least covers the uppermost parts of the organic matter contained in the containers; preferably the container is fully filled with the liquor to ensure the preservation of the entire body of organic matter; a good test to demonstrate the effectiveness of the preserving liquor is to fill and close hermetically a glass container according to this method, but using an amount of liquor which is insufficient to cover the uppermost parts of the organic matter; if this latter is for example a fruit such as banana, it will be seen that after a few days the upper parts thereof, not covered by the preserving liquor, change their color, first turning slightly brown and then darkening more and more, while another container completely filled with the liquor will show no change of color whatsoever; this shows clearly that it is advisable to fill completely the containers with the liquor to protect the entire body of organic matter; and

H) Sealing said containers; the sealing must be hermetic to liquids and to gases, and it may be advisable to do this while the containers are still subjected to said reduced pressure and with or without the use of an atmosphere of inert gas; however the sealing may also be done after the containers have abandoned the reduced pressure zone.

Optionally the containers, once sealed, may be subject to heating under conditions such that the internal temperature of the contents will be raised between 58 and 70°C (usually about 62°C). This heating step is not essential to the method of this invention, but may be convenient to homogenize the liquor and improve still more its penetration within the interstitial spaces of the organic matter tissues. However it will be necessary to be careful not to apply too much heat, to avoid the possibility of degradation of the organic matter according to what has been explained above at length. The above-mentioned heating may be maintained during about 10 to 30 minutes, according to the size and thermal conductivity of the containers.

The effectiveness of this method for preserving perishable organic matter has been exhaustively tested with even the most delicate and sensitive kinds of edible organic matter. Those skilled in the art know that vegetables such as asparagus, bananas, peaches, apricots, strawberries and the like, are very difficult or impossible to preserve with their true full and natural flavour, aroma, colour and texture. None of the methods presently known prevents entirely the deterioration of the organic matter, since there is always a certain loss of at least some of the characteristics of the fresh vegetables, such as texture and/or taste and/or aroma and/or colour. This is true for preserving methods using cold, sterilization by relatively high temperatures such as the Appert Process, chemical preserving additives, dehydration or drying.

Another advantage of the present method is that the preserving liquor constitutes a tasteful syrup which is usable with the preserved fruits, or may be used separately when preparing various kinds of desserts.

The following examples show some manners in which this method may be put into practice.

In all the examples the reduced pressure used during steps (C) to (G) was 14 mm of Hg. In each example, the time during which the containers (and their contents) were subject to the reduced pressure is indicated. To secure a complete removal of oxygen and carbon dioxide from the organic matter, it may be advisable in some cases to maintain the reduced pressure during 50% more than the time indicated. In all examples, containers made of transparent and colorless glass were used, having a capacity of 930 cm^3 with screw-type lids. They were closed without applying reduced pressure during the closing operation. In all examples the end product, that is to say the closed containers with their content of organic matter and preserving liquor was tested by storing it at 21 to 23°C during 30 days, with the only exception of strawberries which were stored during 180 days.

In Examples I and II a preserving liquor No 1 having the following composition was used:

Tartaric acid	0.55%
Potassium sorbate	0.4‰
Saccharose	25.0%
pH	4.2

EXAMPLE I

100% ripened peaches were used, peeled with a 1% caustic soda solution at 95°C during 15 seconds and thereafter with thin but strong water jets at 20 to 21°C. Each container was filled with 600 grams of peeled fruits cut in halves after which their pits were removed. 350 cm3 of liquor No. 1 was added at 40°C. The open containers were subjected to the stated reduced pressure during 16 minutes to ensure a complete impregnation of the organic matter tissues

with the preserving liquor. No heating was used after the containers had been closed. After the storage period the containers were opened and the fruits were extracted therefrom and separated from the preserving liquor. The fruits had a very good and delicate taste, their texture being soft, and had lost only very little of their natural colour. The preserving liquor had a very good taste absolutely resembling the natural taste of the fresh fruit, being very sweet and almost colorless.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the results were very similar to those obtained above, the texture being a little less soft but very good. The liquor was slightly viscous but very palatable.

EXAMPLE II

Bananas were used, which had been previously 100% ripened in chambers with 1.5% of acetylene at 19 to 21°C (accelerated ripening). They were peeled by hand with a stainless steel tool. Each container was filled with 590 grams of peeled fruits (six bananas). 370 cm^3 of preserving liquor No. 1 at 40°C were then added. The open containers were subjected to the stated reduced pressure during 12 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after being closed. After the storage period the containers were opened and the fruits were extracted and separated from the preserving liquor. They had very good taste and a slightly soft texture. The aroma was very natural sweet and agreeable. The liquor had a very natural and delicate taste, being almost colorless and very sweet but mild.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the results were entirely similar, the products (fruits and liquor) having the same properties of taste, texture, aroma and color as those of the products which had not been heated.

In Examples III, IV and V a preserving liquor No. 2 having the following composition was used:

Tartaric acid	4,5%
Potassium sorbate	0,4‰
Saccharose	15,0%
pH	4,4

EXAMPLE III

The raw material were peaches previously conditioned in the same manner as in Example I. The peaches were of Argentine origin of the so called "Tigre" type. Each container was filled with 600 grams of peeled fruits cut in halves and pitted. 315 cm^3 of liquor No. 2 were added at 40°C. The open containers were subjected to the stated reduced pressure during 16 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. No heating was used after the containers had been closed. After the storage period the containers were opened and the fruits were extracted therefrom and separated from the preserving liquor. The fruits had an extraordinarily good taste, slightly sweet and mild, with the perfectly natural colour and texture of the fresh fruit. The liquor had a very good slightly sweet natural taste with excellent flavour resembling that of the fresh fruit, having a slightly yellow colour.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the fruit had an excellent slightly sweet but mild taste and a texture which resembled that of the fresh fruit, and a colour like that of the original product. The liquor had the same characteristics as that of the product not subjected to heating.

EXAMPLE IV

The raw material were bananas of Brazilian origin. The fruits were peeled according to the procedure stated above in Example II. 610 grams of the fruit (6 bananas) were introduced in each of the containers, which were thereafter filled with 360 cm^3 of liquor No. 2 at 40°C. The open containers were subjected to the stated reduced pressure during 12 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. No heating was used after the containers had been closed. After the storage period the containers were opened and the fruits were extracted therefrom and separated from the preserving liquor. The taste of the preserved fruits was mild, slightly sweet and very agreeable, having the texture of the fresh fruit and a light cream colour. The liquor was colourless, having agreeable taste, flavour and sweetness.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the fruits had properties very similar to that of the not afterheated product, but being more aromatic. The liquor was transparent, almost colourless and slightly viscous, while the taste, flavour and sweetness were very agreeable.

EXAMPLE V

The raw material were strawberries 95% ripened, of Argentine origin (Coronda type). The fruits were deprived of their stalks and washed by hand with water at 21 to 22°C. Each container was filled with 610 grams of strawberries, and 360 cm^3 of liquor No. 2 at 40°C was then added. The open containers were subjected to the stated reduced pressure during 8 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after being closed. After the storage period the containers were opened, and the fruits were extracted and separated from the preserving liquor. The fruits had a very good taste entirely like that of the natural fresh fruit and a very natural texture, an agreeable sweetness and a very good external appearance although slightly pale. The liquor had a very good taste, slightly red colour., agreeable sweetness and low viscosity.

When the same procedure was followed, except that the sealed containers were heated to 62°C, before being stored, the fruits had a very good taste, a fairly red colour and agreeable sweetness.

In Examples VI and VII, a preserving liquor No. 3 having the following composition was used:

Tartaric acid	5,5%
Potassium sorbate	0,4‰
Saccharose	15,0%
pH	4,5

EXAMPLE VI

Peeled and halved peaches were used. Each container was filled with 605 grams of fruit; thereafter 310 cm³ of preserving liquid Nc. 3 at 40°C were added. The open containers were subjected to the stated reduced pressure during 16 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after having been closed. After the storage period, the containers were opened and the fruits were extracted and separated from the preserving liquor. The fruits had a peach-like but very harsh taste, a natural tough texture and had the natural colour of the fresh fruit. The preserving liquor had a peach-like harsh taste and a slightly yellow colour, being somewhat turbid due to the flocculation of pectins.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the fruits had a peach-like harsh taste, a natural rather hard and fairly harsh texture when bitten, and only slightly faded colour, and a natural sweetness which however was not capable of concealing the harshness. The preserving liquor had a characteristic peach-like harsh taste, slightly astringent, a slightly yellow colour, and was more turbid than the liquor which had not been afterheated.

EXAMPLE VII

The raw material were bananas. Each container was filled with 595 grams of peeled fruits (six whole bananas), after which 363 cm³ of preserving liquor No 3 at 40°C were added. The open containers were subjected to the stated reduced pressure during 12 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after having been closed. After the storage period the containers were opened and the fruits were extracted and separated from the preserving liquor. The fruits had a harsh taste of unripe banana, a somewhat hard texture, natural colour and good but harsh sweetness. The preserving liquor was colourless and had good but harsh sweetness, with much coagulated pectin.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the fruits and the preserving liquor had the same characteristics as that of the non-afterheated product, except that a higher amount of coagulated pectin was found suspended in the liquid.

In Examples VIII and IX, a preserving liquor No 4 having the following composition was used.

Tartaric acid	2.0 %
Potassium sorbate	0.1 ‰
Saccharose	15.0 %
pH	4.4

EXAMPLE VIII

Peeled and halved peaches were used as raw material. Each container was filled with 600 grams of fruits, after which 318 cm³ of preserving liquor No 4 at 40°C were added. The open containers were subjected to the stated reduced pressure during 16 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after having been closed. After the storage period the containers were opened and the fruits were extracted and separated from the preserving liquor. They had a very good fresh fruit taste, slightly soft texture due to the low content of potassium sorbate, aroma resembling that of the fresh fruit, natural colour, and very mild and palatable sweetness. The preserving liquor was slightly yellowish, had natural sweetness and a very good fresh fruit taste.

When the same procedure was followed, except that the sealed containers were heated to 62°C before being stored, the fruits had exactly the same taste as that of the fresh fruit, a slightly soft texture, very natural and mild aroma and sweetness, and the same natural colour as that of the fresh fruit. The preserving liquor had the same characteristics as that of the non-afterheated product.

EXAMPLE IX

Bananas were used as raw material. The fruits were conditioned and peeled as explained above in Example II. Each container was filled with 593 grams of fruits (six peeled bananas) and thereafter 370 cm³ of preserving liquor No 4 at 40°C were added. The open containers were subjected to the stated reduced pressure during 12 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after having been closed. After the storage period the containers were opened and the fruits were extracted and separated from the preserving liquor. The fruits had exactly the same taste and flavour as those of the fresh fruit. The texture was natural and slightly soft. They had a natural rather cream colour, having the same appearance as that of the fresh fruit. The preserving liquor had very good taste and flavour, and agreeable sweetness and was cristal-clear, not containing suspended pectin coagula.

When the same procedure was followed, but using 0,25‰ potassium sorbate, the results were even better since the very texture of the fresh fruit was maintained.

In Examples X and XI the following No 5 and 6 preserving liquors were used, respectively.

Components	*Liquor No 5*	*Liquor No 6*
Tartaric acid	2.5 %	2.5 %
Potassium sorbate	0.4 ‰	0.4 ‰
Sodium chloride	0.5 %	2.0 %
pH	4.0	4.1

EXAMPLE X

The raw material used was spinach, which was previously bleached by immersion in boiling water during 30 seconds, being afterwards washed with cold water at 22°C. Each container was filled with 608 grams (average) of spinach after which 361 cm³ of liquor No 5 at 40°C were added. The open containers were subjected to the stated reduced pressure during 8 minutes to ensure a complete impregnation of the organic matter tissues with the preserving liquor. The containers were not heated after having been closed. After the storage period the containers were opened and the spinach was extracted and separated from the preserving liquor. The spinach had the natural taste of the fresh vegetable, although

very slightly salty. Its natural texture and green colour were preserved. The preserving liquor was transparent, had a light green colour and a very good taste, though slighly salty.

When the same procedure was followed, except that the sealed containers were heated to 62°C, the spinach had the natural taste of the fresh vegetable, only very slightly salty, with an intense green natural colour and very good texture. The preserving liquor had good taste, was only slightly salty and had an intense green colour.

EXAMPLE XI

The same procedure as that of Example X was followed except that the preserving liquor No 6 was used. The spinach had a natural taste, was rather salty, and had natural texture and colour. The preserving liquor was transparent and had an intense green colour, with a salty taste.

When the same procedure was followed, except that the sealed containers were heated to 62°C the spinach had a natural salty taste, a slightly soft texture and a natural green colour. The preserving liquor was transparent, having a good salty taste and an intense green colour.

According to what has been described and exemplified above, it will be obvious to those skilled in the art that the organic acids of the type of tartaric acid and the like have importance in stabilizing the taste of the preserved product, acting on the sugars and the aromas. The organic acid salt, such as potassium sorbate and the like, acts on the proteins and pectins, stabilizing the texture of the preserved product. However, both perform a complex function in the preserving process, producing a complex stabilizing action that has been already explained above. The use of high amounts of tartaric acid, potassium sorbate, saccharose (or other carbohydrates) or sodium chloride only affect the final taste of the end product which has been preserved according to the present method. On the other hand, the use of a too low amount of these ingredients in the preserving liquor, or the complete lack therein of one or more of them, frustrates entirely the objects and advantages of the present invention. Tartaric acid acts not only as a pH regulator and thus as an inhibitor for the development of micro-organisms, but also has other regulating functions in the preserving process. Potassium sorbate acts both as a preserving agent and as a partner in reactions with proteins and enzymes, stopping their action by forming unstable complexes which prevent degradation or decomposition of the vegetable (or animal) products which are being preserved, maintaining all their nutrient values. The carbohydrates, besides their sweetening characteristics, help in also maintaining the original taste and aroma of the products. Furthermore, they also take part in the formation of stable complexes in the absence of oxygen, said stable complexes recovering their normal activity when they are brought into contact with air. Sodium chloride has a simple activity, acting mainly as a preserving softening agent and fixing the pigments in all food products. In other words, all have a coadjuvant activity which makes basically necessary the elimination of oxygen and carbon dioxide by means of reduced pressure. The minimum absolute pressure to which the organic matter tissues may be subjected is limited by the necessity of avoiding the rupture of the cell walls. The maximum absolute pressure will be determined by the characteristics of the organic matter tissues. The time during which the reduced pressure must be maintained will be less when the reduced pressure is high, and must be longer when the reduced pressure is low. Other like organic acids may be used in substitution of tartaric acid, and various other alkali metal salts may be used in substitution of potassium sorbate, as has been mentioned above.

The main characteristics quoted in the foregoing Examples are summarized in the following Tables I, II and III.

TABLE I
RAW MATERIALS AND PRESERVING LIQUORS USED IN THE EXAMPLES

Example No	Raw material used		Preserving liquor					
				Components				
	Conditioned or organic matter; grams	Subjected to stated reduced pressure during minutes	Amount cm^3	Tartaric acid, %	Potassium sorbate ‰	Saccha-rose, %	Sodium chloride, %	pH
I	Peaches; 600	16	350	0.55	0.4	25	—	4.2
II	Bananas; 590	12	370	0.55	0.5	25	—	4.2
III	Peaches; 600	16	315	4.5	0.5	15.0	—	4.4
IV	Bananas; 610	12	360	4.5	0.5	15.0	—	4.4
V	Strawberries; 610	8	360	4.5	0.5	15.0	—	4.4
VI	Peaches; 605	16	310	5.5	0.4	15.0	—	4.5
VII	Bananas; 595	12	363	5.5	0.4	15.0	—	4.5
VIII	Peaches; 600	16	318	2.0	0.1	15.0	—	4.4
IX	Bananas; 593	12	370	2.0	0.1	15.0	—	4.4
X	Spinach; 608	8	361	2.5	0.4	—	0.5	4.0
XI	Spinach; 608	8	361	2.5	0.4	—	2.0	4.1

TABLE II
STORAGE TIME AND CHARACTERISTICS OF THE END PRODUCT AND THE PRESERVING LIQUOR, WITHOUT AFTER-HEATING

Example No	Storage time, days	Product			Preserving liquor	
		Taste	Texture	Colour	Taste	Colour
I	30	Very good and delicate	Agreeable; soft	Very little loss of natural color	Very good, absolutely natural, very sweet	Colourless
II	30	Very good; sweet natural aroma	Slightly soft	Natural	Natural and delicate; very sweet but mild	almost colourless
III	30	Extraordinarily good, mild and slightly sweet	Natural as that of the fresh fruit	Natural	Very good, natural, slightly sweet	Slightly yellow
IV	30	Mild, slightly sweet, very agreeable	Natural as that of the fresh fruit	Light cream	Agreeable, as well as the flavour; sweetness	Colourless
V	180	Very good and natural; agreeable sweetness	Natural as that of the fresh fruit	Slightly paler than that of the fresh fruit	Very good; agreeable sweetness; slightly viscous	Slightly red
VI	30	Natural, very harsh	Natural, tough	Natural as that of the fresh fruit	Natural; harsh	Slightly yellow; somewhat turbid
VII	30	That of green bananas; harsh sweetness	Somewhat hard	Natural	Good; harsh sweetness	Colourless; much coagulated pectin
VIII	30	Very good; like that of the fresh fruit; mild and agreeable sweetness	Slightly soft	Natural	Very good; like that of the natural fruit; natural sweetness	Slightly yellowish
IX	30	Exactly the same as that of the fresh fruit	Natural; slightly soft	Natural; cream	Very good; agreeable sweetness	Colourless crystal-clear
X	30	Natural; like that of fresh spinach; slightly salty	Natural	Natural; green	Very good; slightly salty	Light green; transparent
XI	30	Natural; salty	Natural	Natural	Natural; salty	Lively green; transparent

TABLE III
STORAGE TIME AND CHARACTERISTICS OF THE END PRODUCT AND THE PRESERVING WITH AFTER-HEATING AT 62°C

Example No	Storage time, days	Product			Preserving liquor	
		Taste	Texture	Colour	Taste	Color
I	30	Very good and mild	Slightly soft but agreeable	Slight loss of natural color	Very good, mild and very sweet	Almost colorless; slightly viscous
II	30	Very good, mild and sweet, good aroma	Slightly soft	Natural	Very good, very sweet but mild	Colorless
III	30	Extraordinarily good and mild; slightly sweet	Very good and mild	Like that of the fresh fruit	Very good and mild; slightly sweet	Slightly yellow
IV	30	Like that of the fresh fruit; very aromatic; agreeable sweetness	Natural	Natural	Sweet; very agreeable	Transparent and almost colorless; slightly viscous
V	180	Extraordinarily good, like that of the fresh fruit	Extraordinarily good, like that of the fresh fruit	Absolutely natural; extraordinary external appearance	Very good; agreeable sweetness	Fairly red
VI	30	Harsh like that of the fresh fruit; natural sweetness which however is not enough to hide its harshness	Natural, rather hard; fairly harsh when bitten	Very slight loss of natural colour	Characteristic of peach, harsh, slightly astringent	Slightly yellow; more turbid then when not after-heated
VII	30	The same characteristics as those of the non-afterheated end product and preserving liquor of Example VII (see Table II)				Even higher amount of suspended coagulated pectin than in the case of the non after-heated liquor
VIII	30	Exactly that of the fresh fruit; natural and very mild sweetness and aroma	Fairly soft	Natural	Some characteristics as those of the non after-heated preserving liquor	
IX		NOT TESTED				
X	30	Natural scarcely salty	Very good	Natural; intense green	Good; scarcely salty	Intense green

Example No	Storage time, days	Product			Preserving liquor	
		Taste	Texture	Colour	Taste	Color
XI	30	Natural; salty	Slightly soft	Natural green	Good; salty	Intense green, transparent

While the present invention has been described in connection with some specific embodiments, those skilled in the art will easily understand that various changes may be introduced therein which however will be encompassed by the scope of the invention as defined in the claims.

CLAIMS

1. A method for preserving perishable organic matter, such as foodstuffs, in sealed containers, characterized by comprising the steps of: (A) conditioning the organic matter, which must be preserved, stripping it from its components not desired in the final product; (B) introducing the organic matter obtained according to (A), into suitable previously conditioned open containers; (C) introducing said containers, still in their open condition, into a substantially hermetic zone which is connected to vacuum producing means; (D) subjecting said organic matter in said zone to a gradually decreasing pressure until attaining a final pressure of not more than about 90 mm of Hg; (E) maintaining this final reduced pressure, according to the nature of said organic matter, during enough time to remove substantially all of the oxygen and carbon dioxide contained in said matter; (F) preparing a stabilizing and preserving liquor comprising (1) at least one non-toxic organic acid the necessary and sufficient amount to obtain in the liquor a pH of about 4.1 to 4.5, (2) at least one salt of a non-toxic organic acid in the necessary and sufficient amount to transitorily stop substantially all metabolic processes normally taking place in said organic matter, (3) at least one agent, selected from the group comprising sodium chloride and a saccharide, in the necessary and sufficient amount to be capable of preserving the texture and taste of the fresh original organic matter, and (4) water as a solvent for the components (1), (2) and (3); (G) filling the containers, while they still are subjected to said reduced pressure, with said stabilizing and preserving liquor in the amount necessary to cover at least with a slight excess, the upper level of said organic matter in the containers; and (H) sealing said containers.

2. A method according to claim 1, characterized by the fact that in said step (F), said liquor has a temperature of about 40°C when it is introduced in said containers.

3. A method according to any of claims 1 or 2, characterized by the fact that after said step (H) the sealed containers are heated until the internal temperature of the organic matter contained therein reaches about 58 to about 69°C and are then maintained at this temperature during about 10 to about 30 minutes.

4. A method according to any of claims 1 or 2, characterized by the fact that after said step (H) the containers are stored at a temperature of about 25 to 30°C during about 10 days to detect any leak in any of said containers.

5. A method according to claim 3, characterized by the fact that after said heating the containers are stored at a temperature of about 25 to about 30°C during about 10 days to detect any leak in any of said containers.

6. A method according to any of the preceding claims, characterized by the fact that said non-toxic organic acid (1) of the stabilizing and preserving liquor of step (F) is a non-toxic organic acid selected from the group comprising tartaric acid, citric acid and lactic acid.

7. A method according to claim 6, characterized by the fact that said non-toxic organic acid is used in an amount of about 0.55 to about 4.5% by weight of the liquor.

8. A method according to any of the preceding claims, characterized by the fact that said salt of non-toxic organic acid (2) of the stabilizing and preserving liquor of step (F) is potassium sorbate.

9. A method according to any of claims 1 to 7, characterized by the fact that said salt of a non-toxic organic acid (2) of the stabilizing and preserving liquor of step (F) is sodium benzoate.

10. A method according to any of claims 1 to 7, characterized by the fact that said salt of a non-toxic organic acid (2) of the stabilizing and preserving liquor of step (F) is a mixture comprising potassium sorbate and sodium benzoate.

11. A method according to any of the preceding claims, characterized by the fact that the total amount used of said salt of a non-toxic organic acid (2) of the stabilizing and preserving liquor of step (F) is from about 0.1 to about 0.4‰ by weight of the liquor.

12. A method according to any of the preceding claims, characterized by the fact that said agent (3) of the stabilizing and preserving liquor of step (F) is sodium chloride.

13. A method according to claim 12, characterized by the fact that said sodium chloride is used in an amount of about 0.5 to 2.0% by weight of the liquor.

14. A method according to any of claims 1 to 11, characterized by the fact that said agent (3) of the stabilizing and preserving liquor of step (F) is a saccharide.

15. A method according to claim 14, characterized by the fact that said saccharide is a saccharide selected from the group comprising saccharose, fructose and glucose.

16. A method according to claim 14, character-

ized by the fact that said saccharide is a synthetic saccharide.

17. A method according to claim 16, characterized by the fact that said synthetic saccharide is saccharin.

18. A method according to any of the preceding claims 14 to 17, characterized by the fact that said saccharide is used in an amount of about 2 to about 25% by weight of the liquor.

19. A method according to claim 1, characterized by the fact that said final reduced pressure used in said steps (D) (E) and (G) is of not more than 25 mm of Hg.

20. A preserving liquor for preserving perishable organic matter, which after the preservation period is also usable as a syrup for adding to desserts and other foodstuffs, characterized by comprising (1) at least one non-toxic organic acid in the necessary and sufficient amount to obtain in the liquor a pH of about 4.1 to 4.5, (2) at least one salt of a non-toxic organic acid in the necessary and sufficient amount to transitorily stop substantially all metabolic processes normally taking place in said organic matter, (3) at least one agent, selected from the group comprising sodium chloride and a saccharide, in the necessary and sufficient amount to be capable of preserving the texture and taste of the fresh original organic matter and (4) water as a solvent for the components (1), (2) and (3).

21. A preserving liquor according to claim 20, characterized by the fact that said non-toxic organic acid (1) is a non-toxic organic acid selected from the group comprising tartaric acid, citric acid and lactic acid.

22. A preserving liquor according to claim 21, characterized by the fact that said non-toxic organic acid is used in an amount of about 0.55 to about 4.5% by weight of the liquor.

23. A preserving liquor according to any of claims 20 to 22, characterized by the fact that said salt of a non-toxic organic acid (2) is potassium sorbate.

24. A preserving liquor according to any of claims 20 to 22, characterized by the fact that said salt of a non-toxic organic acid (2) is sodium benzoate.

25. A preserving liquor according to any of claims 20 to 22, characterized by the fact that said salt of a non-toxic organic acid (2) is a mixture comprising potassium sorbate and sodium benzoate.

26. A preserving liquor according to any of claims 20 to 25, characterized by the fact that the total amount used of said salt of a non-toxic organic acid (2) is from about 0.1 to about 0.4‰ by weight of the liquor.

27. A preserving liquor according to any of claims 20 to 26, characterized by the fact that said agent (3) is sodium chloride.

28. A preserving liquor according to claim 22, characterized by the fact that said sodium chloride is used in an amount of about 0.5 to 2.0 by weight of the liquor.

29. A preserving liquor according to any of claims 17 to 21, characterized by the fact that said agent (3) is a saccharide.

30. A preserving liquor according to claim 24, characterized by the fact that said saccharide is a saccharide selected from the group comprising saccharose, fructose and glucose.

31. A preserving liquor according to claim 24, characterized by the fact that said saccharide is a synthetic saccharide.

32. A preserving liquor according to claim 31, characterized by the fact that said synthetic saccharide is saccharine.

33. A preserving liquor according to any of claims 29 to 32, characterized by the fact that said saccharide is used in an amount of about 2 to 25% by weight of the liquor.

34. A perishable organic matter preserved by a method according to any of claims 1 to 19.

35. A method for preserving perishable organic matter, such as foodstuffs, in sealed containers, substantially as has been described in the specification.

36. A preserving liquor for preserving perishable organic matter, substantially as has been described in the specification.

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(54) Intermediate moisture food products

(57) Pasteurised intermediate moisture food products have a water activity of from 0.86 to 0.91 and a pH of from 4.5 to 5.5, the food products having been pasteurised in containers which have been hermetically sealed before, during or immediately after pasteurisation. The food products may be stored for extended periods without refrigeration and without spoilage by microbial or mould generation. The preparation of intermediate moisture vegetables, vegetable cakes, tortellini, pancakes and waffles are particularly described.

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SPECIFICATION

Intermediate moisture food products

This invention relates to intermediate moisture food products.

Intermediate moisture food products have been developed in recent years as storable food products which do not require special storage conditions such as refrigeration, canning and the like, but which substantially retain the characteristics of the original food product. Such products are sometimes known as "semi-moist" foods as they have a moisture content between that of a food having its usual moisture content and a dried food. In general such foods have a moisture content greater than 10% and less than 50% by weight.

The microbiological stability of intermediate moisture food products characteristically is provided partly or wholly by reducing the amount of water available for vital processes incident to microbial growth and spore germination and outgrowth. As the amount of water available for such spoilage processes bears a close relationship to the vapour pressure of the water in the product (since the vapour pressure is a function of unbound water), it has become the practice in the art to characterise intermediate moisture food products by their water activity, A_w, which is defined by the relationship

$$A_w = P/Po$$

(wherein P is the vapour pressure of water in the food, and Po is the vapour pressure of pure water at the same temperature). In general, most micro-organisms can grow when the water activity is in the range 0.97 to 1.00, but a large proportion of common bacteria will not grow if the water activity is below 0.91. Yeasts and moulds generally require the water activity to be below 0.88 and 0.80 respectively to prevent growth. Similarly, staphylococcus organisms, halophilic bacteria, xerophilic moulds and osmophilic yeasts generally will not grow if the water activity is below 0.85, 0.75, 0.65 and 0.60 respectively.

Intermediate moisture food products are at present generally prepared with water activities in the range 0.60 to 0.85. However, it is desirable to ensure that the water activity is as high as possible, while ensuring the avoidance of risk of spoilage or growth of pathogenic bacteria, in order to preserve more natural organoleptic properties and textures. Such known products often incorporate antimicrobial agents when the water activity is in the upper end of the above range, in order additionally to control the growth of undesired organisms in the products but it would be preferable if such additives could be avoided.

Water activities below 0.91 are sufficiently low to inhibit the growth of all heat resistant bacteria but certain heat sensitive bacteria, yeasts and moulds are still able to to proliferate at relatively high water activities below 0.91. *Staphylococcus aureus* is of particular significance in this respect. It has therefore sometimes been the practice to pasteurise intermediate moisture food products prior to packaging in order to kill any heat sensitive organisms. However, the pasteurisation techniques which have been employed either are not fully effective in killing all the microorganisms as these have an increased heat resistance at the water activity levels which have been used in known intermediate moisture food products or are so severe that poor quality products result. In addition, pasteurisation has hitherto been effected prior to packaging the food products and this has given rise to a risk of re-contamination with undesirable microorganisms in subsequent packaging procedures.

It is therefore an object of the present invention to provide intermediate moisture food products having a relatively high water activity, but with adequate resistance to spoilage and production of toxic products by growth of microorganisms.

We have found that the above objects may be achieved by combining a relatively high water activity with controlled acidity and by pasteurisation of the food product in a container which is hermetically sealed before, during or immediately after pasteurisation.

Thus, according to one aspect of the present invention there is provided a pasteurised, intermediate moisture food product having a water activity of from 0.86 to 0.91 and a pH of from 4.5 to 5.5, said food product having been pasteurised in containers which have been hermetically sealed before, during or immediately after pasteurisation.

According to a further aspect of the invention there is provided a process for the preparation of intermediate moisture food products which comprises pasteurising a food product having a water activity of from 0.86 to 0.91 and a pH of from 4.5 to 5.5, within a container and hermetically sealing the container before, during or immediately after pasteurisation.

The desired level of water activity of the intermediate moisture food products according to the invention may be conveniently achieved by two methods. The first of these methods comprises physically reducing the water content by drying the food product itself or some or all of the raw ingredients thereof. Of course it is also possible to use a combination of these drying methods, whereby the raw ingredients are dried as well as drying of the food product itself. The second method of reducing the water activity of the food product according to the invention is to incorporate at least one edible humectant, which binds a proportion of water to such an extent that it is unavailable for microbial growth. Such humectants include water-soluble sugars, salts, polyhydric alcohols and acids. From economic considerations and having regard to the flavouring and ease of use characteristics of such humectants, it is preferred to use glycerol, sucrose, dextrose, propylene glycol, sodium chloride and/or sorbitol, for this purpose. In general, however, it is preferred to use a combination of both of the above techniques, that is to dry some or all of the ingredients or the food product itself, and to incorporate a humectant or mixture of humectants.

The food products according to the invention have

a pH in the range 4.5 to 5.5 and this may be achieved by incorporating a suitable amount of, for example, an acceptable food acid such as acetic, citric, lactic, malic or tartaric acid, into the food product. If the use of a free acid in the food product would affect its properties by reaction with other ingredients, such as for example in farinaceous products containing raising agents, it is preferred to incorporate an acidulating agent which will avoid such reaction. For example, we have found that glucono-δ-lactone or sodium acid pyrophosphate may be used as acidulants in batter-derived food products containing raising agents.

The food products according to the invention are packaged with hermetically sealable containers and are pasteurised therein. This pasteurisation may be effected by hot filling the containers and/or by subsequently heating of the filled containers, for example by steam or hot water, by microwave heating, or by a combination thereof. It should be noted that pasteurisation will not necessarily kill all undesired organisms in the food products according to the invention, but the growth of any microorganisms surviving pasteurisation will be inhibited by the combination of low water activity and low acidity in the food products. In general, pasteurisation will be sufficient to kill all non-sporing microorganisms and many heat-sensitive sporing microorganisms, such as yeasts and moulds. Thus, the pasteurisation process will be sufficient to kill those microorganisms which may be capable of multiplication at the levels of water activity and pH present in the food products according to the invention.

The use of relatively high water activities in the food products according to the invention may give rise to improved properties compared with intermediate moisture food products having lower water activities. In particular, the higher water activity requires the use of smaller quantities of humectants for preservation with a consequent improvement in flavour or organoleptic characteristics. In addition the food products are "moister" to the palate. The increased moistness also improves the reheating properties of the food products according to the invention when these are being prepared for consumption, as heat transference is more efficient. This characteristic is of particular importance when the food products of the invention are in the form of the so-called "boil-in-the-container" type.

A further advantage of the use of relatively high water activities of the food products according to the invention is that the pasteurisation efficiency is improved as a result of the better heat transfer properties.

We have found that the use of relatively high water activities in conjunction with controlled addification in food products according to the invention renders microorganisms more susceptible to the damaging effects of mild heat treatment, such as pasteurisation, than is the case in hitherto known intermediate moisture food products.

The intermediate moisture food products according to the present invention do not require the presence of antimycotic agents. The avoidance of the use of such agents is especially desirable in view of the restriction on the use of such products in some areas and also the sales resistance which may be encountered when the presence of such agents is indicated on product labels.

The in-pack pasteurisation process used in the preparation of intermediate moisture food products according to the invention prevents any recontamination of the food products which is possible in the hitherto used procedures of pasteurisation prior to packaging.

The present invention is of particular applicability to food products of the pancake or waffle type. Thus in certain embodiments of the invention there are provided fully cooked pancakes and waffles in hermetically sealed containers such that they may be readily reheated prior to consumption. Such pancakes and waffles may be stored for extended periods without refrigeration and do not significantly deteriorate during such periods. When reheated these pancakes and waffles are of comparable flavour, aroma, appearance and texture compared to freshly prepared pancakes and waffles.

Pancakes and waffles according to the invention may be produced by cooking batters containing such levels of humectant and/or such levels of water that the resultant water activity of the cooked products is in the range 0.86 to 0.91. For example we have found that batters containing from 0 to 18%, preferably about 8%, of glycerol together with from 15 to 5%, preferably about 9%, of dextrose monohydrate, and having a moisture content of from 35 to 55%, preferably about 45%, will give fully cooked pancakes or waffles having a glycerol content of from 0 to 20%, a dextrose content of from 20 to 5% and a moisture content of from 32 to 42%. When pancakes or waffles are prepared using batters containing the above mentioned preferred levels of glycerol, dextrose and moisture, the fully cooked products generally contain about 7.0% glycerol, 10% dextrose and 37% moisture.

The pancakes and waffles according to the invention may be prepared from batters which incorporate the usual components such as, for example, edible oils or shortenings such as for example, hydrogenated and non-hydrogenated forms of groundnut oil, coconut oil, cottonseed oil, sunflower oil, palm kernal oil and mixtures thereof; eggs; salt; flour; milk; whey; and raising or leavening agents.

As indicated above the preferred acidulating agents for batters containing raising agents such as sodium bicarbonate, are glucono-δ-lactone or sodium acid pyrophosphate.

Pancakes and waffles according to the invention may be conventionally cooked on a hot plate or griddle and may be then packed into hermetically sealable containers and pasteurised.

The method of the invention may conveniently be applied to vegetables and vegetable based products. Thus, for example, onions may be sliced, steeped in humectant, pressed to remove excess liquor and air-dried to give an intermediate moisture product of about 25% of the weight of the original onions. This product may then be mixed with further humectant, filled into plastic pouches and pasteurised.

We have also found that the present invention is

applicable to pasta products such as, for example, tortellini.

The following Examples serve to illustrate the production of food products according to the invention:–

Example 1: Ready-to-eat Pancakes

Ingredients:	Flour	24.0%
	Sodium bicarbonate	0.3%
	Salt	0.7%
	Dextrose	9.2%
	Sugar	2.5%
	Glucono-δ-lactone	0.5%
	Whey Powder	2.0%
	Egg	12.3%
	Vegetable Oil	3.1%
	Glycerol	3.3%
	Water	37.1%
		100.0%

The flour, sodium bicarbonate, acidulant, whey powder, salt, dextrose and sugar were mixed together. The egg was added with a little water and mixed in thoroughly. The oil, glycerol and remaining water were then added sequentially and the mixture was mixed to form a smooth homogenous batter. The batter was then transferred to pancake moulds placed on a greased hotplate. The pancakes were cooked on each side. The A_w of the batter was approximately 0.93 at 25°C and its pH was 5.5. The A_w of the cooked pancake product was 0.87 at 25°C and its pH was 5.4.

The pancakes were transferred to thermoformed trays formed from a heat-processible plastics laminate. The trays were hermetically sealed using a lid film of heat-processible plastics laminate. The tray and contents were then placed in a microwave oven and were heated such that the centre of the pack reached a temperature of 95°C. The pack was then transferred to a steam tunnel and pasteurised.

Microbiological examination of the cooked pancake product of this Example was carried out after one month and three months' storage at 37°C. The standard plate count and the mould/yeast counts were less than 10^2, and less than 10 respectively.

Example 2: Ready-to-eat Waffle product

Ingredients:	Flour	29.8%
	Sodium bicarbonate	0.4%
	Salt	0.8%
	Dextrose	11.6%
	Sugar	2.5%
	Glucono-δ-lactone	0.8%
	Whey Powder	2.1%
	Egg	15.6%
	Vegetable Oil	5.0%
	Glycerol	7.5%
	Water	23.9%
		100.0%

The ingredients were mixed together as in Example 1 and the prepared batter was used to make round waffles. The A_w of the waffle batter was approximately 0.93 at 25°C and its pH was 5.5. The waffles were cooked on each side on a hotplate. The waffles were then transferred to cans. The cans were hermetically closed and then the packs were pasteurised. The A_w of the cooked product was 0.87 at 25°C and its pH was 5.4.

Microbiological examination of the cooked product of this Example was carried out in the same way as for Example 1. The results were substantially the same as for Example 1.

Example 3: Onions for frying

Sliced onions were treated with humectants and citric acid, the mixture having the following composition:

Onions, sliced	88.0%
Salt	3.5%
Sorbitol	4.5%
Sugar	3.6
Citric acid	0.4%
	100.0%

The sliced onions were contacted with the liquor for two hours and pressed to remove excess liquor. This pre-treated product had a weight of about 55% based on the original weight of raw sliced onion taken. The pressed onion was then dried to give a treated onion product of about 25% by weight based on the original raw weight taken. The treated onion was then mixed thoroughly with glycerol in the following proportions:–

Onions, sliced, treated	91%
Glycerol	9%
	100

It was then filled into flexible heat-processible plastics pouches. The pouches were partially sealed and the pack was then transferred to a steam tunnel and pasteurised. The sealing was completed immediately after pasteurisation and the product allowed to cool. The water activity of the cooled product was 0.86 at 25°C and it pH was 4.8.

Microbiological examination of the pasteurised onion product of this Example was carried out in the same way as for Example 1. The results were substantially the same as for Example 1.

Example 4: VEGETABLE CAKE FOR FRYING

Ingredients:–

Tomato Puree (36% T.S.S.)	4.5%
Dried egg	3.4
Whole egg	11.4%
Vegetable oil	11.4%
Salt	1.0%
Glycerol	3.7%
Rusk, ground	13.3%
Textured vegetable protein granules, treated.	11.4%
Onion, diced, treated	17.1%
Carrots, diced, treated	22.8%
	100.0

The textured vegetable protein was treated by adding one part of mince size granules to three parts of a solution containing 16.0% glycerol by weight and 6% salt by weight and then boiling for 5 minutes. The treated granules were separated from the liquor and drained. The carrots were treated by peeling and dicing to give 6 mm x 6 mm x 6 mm cubes, cooking in four times their own weight of water to achieve a satisfactory texture, soaking one part of the cooked carrot for 20 minutes at 50°C in two parts of a solution containing 11.8% of glycerol and 3.9% of salt, separating from the soak solution and draining and drying to about 44% of their soaked weight. The onions were treated by peeling and dicing to 6 mm x 6 mm x 3 mm dice, cooking in four times their own weight of water to achieve a satisfactory texture, soaking one part of the cooked onion for 20 minutes at 50°C in two parts of a solution containing 13.5% of glycerol and 4.3% of salt, separating from the soak solution and draining, and drying to about 46% of their soaked weight.

The vegetable cake was prepared in two stages. Firstly the tomato puree, dried and whole egg, vegetable oil, salt, glycerol and rusk were mixed together thoroughly. Then the treated vegetables were added to this mix. The complete mix was divided into portions and these were moulded into square form cakes. The cakes were placed in heat-processible plastics pouches. The pouches were partially sealed and preheated in a microwave oven until the centre of the pack reached 90°C. Sealing was completed and the packs were then pasteurised. The water activity of the cooked product was 0.86 at 25°C and its pH was 4.9. Microbiological examination of the pasteurised onion product of this Example was carried out in the same way as for Example 1. The results were substantially the same as for Example 1.

Example 5 TORTELLINI

Ingredients:

Pasta

Citric Acid	0.3
Semolina, Durum wheat	74.0%
Egg	21.7%
Water	4.0%
	100.0%

Filling

Breadcrumbs	45.0%
Beef, cooked	35.0%
Onions, cooked	0.4%
Cheese	4.0%
Sodium Glutamate	9.0%
Salt	3.0%
Spices	0.3%
citric acid	0.3%
	100.0%

The beef and onions were precooked together with a little added salt. They were then cooled. This blend was then ground, transferred to a mixer and the remainder of the filling ingredients were added. The filling was mixed and then fed to a tortellini former.

The semolina flour, citric acid, egg and water were weighed out and mixed. The mass was fed to a sheet extruder and thence to the tortellini former. Tortellini were formed having about 30% by weight of filling and 70% by weight of pasta. The whole tortellini were blanched and then dried to 25% moisture content by weight based on the total pasta and filling together. The whole tortellinis were packed into thermoformed trays formed from a heat-processible plastics laminate. The trays were hermetically sealed using a lid film of heat-processible plastics laminate. The sealed packs were pasteurised. The product was cooled. The resultant A_w was 0.89 at 25°C and its pH was 5.4. When the two parts of the product – the filling and the pasta – were separated and tested, it was found that equilibration of the water activities had occurred through migration of salt and sodium glutamate from the filling to the pasta during the production process. The pH's of each component were also in equilibrium.

A microbiological examination of the product from Example 5 was carried out in the same way as that for Example 1 and the results were substantially the same as for Example 1.

CLAIMS

1. A pasteurised intermediate moisture food product having a water activity of from 0.86 to 0.91 and a pH of from 4.5 to 5.5, said food product having been pasteurised in containers which have been hermetically sealed before, during or immediately after pasteurisation.

2. A food product as claimed in claim 1 wherein the water activity is obtained by drying the food product or at least a part of the ingredients thereof or by incorporating at least one edible humectant into the food product, or by a combination thereof.

3. A food product as claimed in claim 2 wherein the humectant is selected from water-soluble sugars, salts, polyhydric alcohols and acids, or a mixture thereof.

4. A food product as claimed in claim 3 wherein the humectant is selected from glycerol, sucrose, dextrose, polypropylene glycol, sodium chloride and sorbitol or a mixture thereof.

5. A food product as claimed in any of the preceding claims wherein the pH in the range of 4.5 to 5.5 is achieved by incorporating acetic, citric, lactic,

malic or tartaric acid, glucono-δ-lactone or sodium acid pyrophosphate, into the food product.

6. A food product as claimed in any of the preceding claims wherein the pasteurisation is effected by heating with steam or hot water, or by microwave heating, or by a combination thereof.

7. A food product as claimed in any of the preceding claims in the form of a pancake, waffle, vegetable, vegetable based product or pasta product.

8. A pasteurised intermediate moisture food product substantially as herein described in any of the Examples.

9. A process for the preparation of pasteurised intermediate moisture food products which comprises pasteurising a food product having a water activity of from 0.86 to 0.91 and a pH of from 4.5 to 5.5 in a container and hermetically sealing the container before, during or immediately after pasteurisation.

10. A process as claimed in claim 9 substantially as herein described.

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